INDOOR AIR QUALITY ASSESSMENT

Alternative Education High School
111 Goodrich Street
Fitchburg, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health
Indoor Air Quality Program
October 2010

Background/Introduction

At the request of Mr. William Barletta, Facilities Director for the Fitchburg Public Schools, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) conducted an indoor environmental assessment at the Alternative Education High School (AEHS) located at 111 Goodrich Street, Fitchburg, Massachusetts. This assessment was part of an ongoing effort to monitor and improve indoor air quality conditions at Fitchburg schools. On April 7, 2010, Lisa Hébert, Environmental Analyst/Regional Inspector for BEH's Indoor Air Quality (IAQ) Program, made a visit to the AEHS to conduct an indoor air quality assessment.

The AEHS is a red brick building that was constructed in 1891 as an eight room school-house. The building is a two-story structure with an occupied basement. An interior renovation was conducted in 1987. In 2007, the AEHS took occupancy of the building. Windows are openable throughout the building.

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were conducted with the TSI, Q-Trak, IAQ Monitor, Model 7565. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. BEH staff also performed visual inspection of building materials for water damage and/or microbial growth.

Results

The school houses approximately 150 middle and high school students with a staff of approximately 16. Tests were taken during normal operations and results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were below 800 parts per million (ppm) in all 16 areas surveyed, indicating adequate air exchange throughout the building. Fresh air in classrooms is supplied by a unit ventilator (univent) system (Figure 1). Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building and return air through an intake located at the base of each unit. The mixture of fresh and return air is drawn through a filter and heating coil, and is then expelled from the univent by motorized fans through fresh air diffusers (Picture 1).

One classroom is equipped with mechanical exhaust ventilation, which is provided by a unit exhaust ventilator. A unit exhaust ventilator appears similar to a univent, but removes air from the classroom and exhausts it out of the building. The building was originally designed to provide heated air by means of wall-mounted vents and stale air was originally exhausted to the roof by means of ducted exhaust vents located near the floor. This type of system was known as a natural gravity system. Some of the vents to this abandoned system were obstructed, while others were not, therefore many of the exhaust vents likely provide some measure of exhaust by means of gravity, rather than by mechanical means (Pictures 2 through 4).

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The date of the last balancing of these systems was not available at the time of the assessment.

The Massachusetts Building Code requires that each room have a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or openable windows (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The MDPH uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, consult Appendix A.

Indoor temperature measurements ranged from 65º F to 77º F, which were within the MDPH recommended comfort range in half of the areas surveyed on the day of the assessment (Table 1). The MDPH recommends that indoor air temperatures be maintained in a range of 70º F to 78º F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. In addition, it is difficult to control temperature and maintain comfort without operating the ventilation equipment as designed (e.g., univents/exhaust vents deactivated/abandoned/obstructed).

The relative humidity measured in the building ranged from 39 to 60 percent, which was within the MDPH recommended comfort range during the assessment, with the exception of the front lobby (Table 1). The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. It is important to note however, that relative humidity measured indoors exceeded outdoor measurements (range +12 to 33 percent). It was also reported that dehumidifiers operate in the basement year round. This increase in relative humidity can indicate that the exhaust system alone is not operating sufficiently to remove normal indoor air pollutants (e.g., water vapor from respiration).

Moisture removal is important since the sensation of heat conditions increases as relative humidity increases (the relationship between temperature and relative humidity is called the heat index). As indoor temperature rises, the addition of more relative humidity will make occupants feel hotter. If moisture is removed, the comfort of the individuals is increased. Removal of moisture from the air, however, can have some negative effects. The sensation of dryness and irritation is common in a low relative humidity environment. Relative humidity levels in the building would be expected to drop during the winter months due to heating. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

Several potential sources of water damage and/or moisture infiltration were observed during the assessment. As can be seen in Picture 5, water leaking through the roof was gathered by sheets of plastic and collected in a large plastic refuse container in the attic. The water collected was set up to be pumped via a hose running through an attic window to the exterior of the building (Picture 6). Attic windows covered by plywood were not weathertight and exhibited signs of water penetration (Picture 7). Water-damaged ceilings and walls were also observed in several areas (Picture 8). A large number of materials that can support mold growth were also being stored in the attic, including numerous cardboard boxes (Picture 9). All porous materials stored in this unconditioned location have the potential for mold colonization and should be discarded. Standing water was observed in the basement due to a leaking boiler (Picture 10). BEH staff were informed that boiler replacement was in the planning stages.

A water fountain was observed to have been installed over a carpeted area (Picture 11). Overflow or spills that often occur can moisten carpeting, which can lead to mold growth. Carpets were also observed in basement areas. Basement areas can become moist with condensation during hot, humid summer months. Relative humidity concentrations indoors above 70 percent can foster mold growth in susceptible materials (ASHRAE, 1989). Materials that can foster mold growth if repeatedly exposed to high humidity include cardboard, paper, books, cloth and other materials in addition to carpeting. Therefore, alternative (non-porous) floor coverings should be considered in basement areas when these carpets are due for replacement.

The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommend that porous materials be dried with fans and heating within 24 to 48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If not dried within this time frame, mold growth may occur. Once mold has colonized porous materials, they are difficult to clean and should be removed and discarded.

In addition to the aforementioned roof leak, numerous exterior conditions were observed that can contribute to moisture penetration through the building envelope:

- Loose, missing and broken bricks were observed above second floor windows (Picture 12);
- Masonry lacked mortar in several areas (Picture 13);
- Portions of the gutter and several cast iron downspouts were open and/or in disrepair (Pictures 14 and 15);
- Heavy moss accumulation was observed on exterior walls, particularly behind downspouts (Pictures 16 and 17). The presence of moss is indicative of repeated water exposure. Moss is a sign of chronic dampness and can hold moisture against building components, which can subsequently accelerate its decomposition;
- Some windows were in disrepair (Pictures 18 and 19);
- Caulking around windows was missing and/or damaged (Pictures 18 through 20). Window sealant may be composed of regulated materials (e.g., asbestos, polychlorinated biphenyls or PCBs). For further information regarding PCBs in schools, please consult MDPH guidance in Appendix B;

- Missing/damaged mortar at the edge of exterior walls and tarmac;
- Numerous weeds at the base of the building and plants adjacent to the building;
- Utility holes lacking sealant were seen in exterior walls (Picture 21);
- Peeling paint was observed on trim around attic windows. This condition allows moisture to have prolonged contact with the wooden trim, which can in turn cause the wood fibers to deteriorate at an accelerated pace;

The aforementioned conditions represent potential water penetration sources. Over time, these conditions can undermine the integrity of the building envelope and provide a means of water entry into the building via capillary action through foundation concrete and masonry (Lstiburek & Brennan, 2001). In addition, these breaches may provide a means for pests/rodents to enter the building.

Other IAQ Evaluations

Indoor air quality can be negatively influenced by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants. Common combustion emissions include carbon monoxide, carbon dioxide, water vapor, and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers (μm) or less (PM2.5) can produce immediate, acute health effects upon exposure. To determine whether combustion products were present in the indoor environment, BEH staff obtained measurements for carbon monoxide and PM2.5.

Carbon Monoxide

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health effects. Several air quality standards have been established to address carbon monoxide and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

The American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE) has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from six criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2006). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS levels (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2006).

Carbon monoxide should not be present in a typical, indoor environment. If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. Outdoor carbon monoxide concentrations were non-detect (ND) the day of the assessment (Tables 1). No measureable levels of carbon monoxide were detected in the building during the assessment (Table 1).

Particulate Matter

The US EPA has established NAAQS limits for exposure to particulate matter. Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. The NAAQS originally established exposure limits to particulate matter with a diameter of 10 μm or less (PM10). According to the NAAQS, PM10 levels should not exceed 150 micrograms per cubic meter ($\mu g/m^3$) in a 24-hour average (US EPA, 2006). These standards were adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, US EPA established a more protective standard for fine airborne particles. This more stringent PM2.5 standard requires outdoor air particle levels be maintained below 35 $\mu g/m^3$ over a 24-hour average (US EPA, 2006). Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, MDPH uses the more protective PM2.5 standard for evaluating airborne particulate matter concentrations in the indoor environment.

Outdoor PM2.5 concentrations were measured at 21 $\mu g/m^3$ (Table 1). PM2.5 levels measured indoors ranged from 15 to 20 $\mu g/m^3$ (Table 1), which were below the NAAQS PM2.5 level of 35 $\mu g/m^3$. Frequently, indoor air levels of particulates (including PM2.5) can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur in buildings can generate particulate during normal operations. Sources of indoor airborne particulates may include but are not limited to particles generated during the operation of fan belts in the HVAC system, use of stoves and/or microwave ovens in kitchen areas; use of photocopiers, fax machines and computer printing devices; operation of an ordinary vacuum cleaner and heavy foot traffic indoors.

Volatile Organic Compounds

Indoor air concentrations can be greatly impacted by the use of products containing volatile organic compounds (VOCs). VOCs are carbon-containing substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs.

In an effort to identify materials that can potentially increase VOC concentrations, BEH staff examined classrooms for products that may contain these respiratory irritants. Several classrooms contained dry erase boards and dry erase board markers. Materials such as permanent markers, dry erase markers and dry erase board cleaners may contain VOCs, such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999), which can be irritating to the eyes, nose and throat.

Other Conditions

Other conditions that can affect indoor air quality were observed during the assessment. Evidence of rodent activity was observed in the attic (Pictures 22 and 23). To penetrate the exterior of a building, rodents require a minimal breach of ¼ inch (MDFA, 1996). Utility holes on the exterior of the building and other breaches in the building envelope would be sufficient to allow rodents to enter the building. Rodent infestation results from easy access to food and water in a building. Rodent infestation can result in indoor air quality related symptoms due to materials in their wastes. Mouse urine contains a protein that is a known sensitizer (US EPA, 1992). A three-step approach is necessary to eliminate rodent infestation:

1. removal of the rodents;
2. removal of waste products from the interior of the building; and
3. reduction/elimination of harborage/pathways/food sources that are attracting rodents.

To eliminate exposure to allergens, rodents must be removed from the building. Please note that removal, even after cleaning, may not provide immediate relief since allergens can exist in the interior for several months after rodents are eliminated (Burge, 1995). A combination of cleaning, increase in ventilation and filtration should serve to reduce rodent associated allergens once the infestation is eliminated. Under current Massachusetts law that went into effect November 1, 2001, the principles of integrated pest management (IPM) must be used to remove pests in schools (Mass Act, 2000).

Numerous open utility holes and large penetrations through gypsum wallboard were observed (Picture 24). An open-ended pipe was observed in a basement storage area. These conditions may allow dust, particulate matter, odors and vapors to move from one room to another and may irritate the respiratory systems of sensitive individuals. Peeling paint was also observed on water-damaged ceilings and walls.

Upholstered furniture was noted in some classrooms. Close contact with such items can leave behind oils, perspiration, hair and skin cells. Dust mites feed upon human skin cells and excrete waste products that contain allergens. Carpets were worn and frayed in some areas. Carpet in schools has a usable life span of eleven (11) years (IICRC, 2002). Therefore, it is possible that many carpets have exceeded their lifespan.

Dry sink and floor drains were observed in several areas. The purpose of a drain trap is to prevent drainage system gases and odors from entering the occupied space. When water is poured into a trap, an airtight seal is created by the water in the U-bend section of the pipe.

These drains must have water poured into the traps at least twice a week to maintain the integrity of the seal. Without water, the drain opens the room to the drainage system. If a mechanical device (e.g., exhaust fan) depressurizes the room, air, gas and odors can be drawn from the drainage system into the room. The effect of this phenomenon can be increased if heavy rains cause an air backup in the system.

Conclusions/Recommendations

The conditions noted at the AEHS raise a number of indoor air quality issues. The general building conditions, age/condition of HVAC equipment alone present conditions that could degrade indoor air quality. When combined, these conditions can serve to further degrade indoor air quality. Some of these conditions can be remedied by actions of building occupants. Other remediation efforts will require alteration to the building structure and equipment. For these reasons, a two-phase approach is recommended for remediation. The first consists of **short-term** measures to improve air quality and the second consists of **long-term** measures that will require planning and resources to adequately address overall indoor air quality concerns.

The following **short-term** recommendations are made for consideration:

1. Contact an HVAC engineering firm to evaluate the current ventilation system components given their age and to make repairs and adjustments as necessary in order to provide adequate fresh air and exhaust and to reduce the relative humidity in all rooms in the building.
2. Operate all ventilation systems throughout the building continuously during periods of occupancy independent of thermostat control to maximize air exchange.

3. Use openable windows in conjunction with mechanical ventilation to facilitate air exchange. In the winter, care should be taken to ensure windows are properly closed at night and on weekends to avoid the freezing of pipes and potential flooding.
4. Consider adopting a balancing schedule of every 5 years for all mechanical ventilation systems, as recommended by ventilation industrial standards (SMACNA, 1994).
5. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
6. Continue with plans to repair the roof.
7. Repair any existing water leaks (particularly in the attic); repair water-damaged surfaces. Disinfect areas of water leaks with an appropriate antimicrobial, as needed.
8. Remove unnecessary porous materials in the attic.
9. Continue with plans to repair/replace leaking boiler.
10. Ensure a mat impervious to water is placed beneath the water fountain to prevent spillage from moistening the carpet.
11. Pour water into unused drains twice a week (or as needed) to maintain an airtight seal.
12. Ensure dehumidifiers are cleaned and maintained as per the manufacturer’s instructions to prevent microbial growth.

13. Repair or remove peeling paint on both the interior and exterior of the building. Renovation work must be completed in accordance with all state and federal regulations.
14. Contact a building contractor/mason to repair second floor masonry adjacent to window.
15. Repair mortar on exterior of building.
16. Remove moss accumulation on masonry and mortar.
17. Ensure repairs are made to gutters and downspouts. Once water is properly collected and directed away from the building, moss growth on exterior brick should decrease.
18. Repair window casings. Prior to conducting any work on windows and window sealants, consult MDPH guidance on PCBs in Schools in Appendix B.
19. Repair mortar at edge of wall and tarmac.
20. Eliminate weeds at base of building.
21. Seal open utility holes on exterior of the building.
22. Routinely clean dry erase board trays to reduce accumulation of particulate.
23. Take steps to ensure rodents and their wastes are removed from the building. Eliminate food sources and seal pathways for movement within the building. Seal all breaches in the exterior building envelope. Eliminate rodent harborage by reducing weeds adjacent to the building’s exterior and by eliminating unused cardboard and other materials that can be utilized as bedding material.
24. Seal open utility holes through gypsum wallboard.
25. Investigate source of open ended pipe in storage area; seal or remove pipe as warranted.
26. Routinely vacuum upholstered furniture, if not feasible consider removing.
27. Clean carpeting annually (or semi-annually in soiled high traffic areas) as per recommendations of The Institute of Inspection, Cleaning and Restoration Certification

(IICRC). Copies of the IICRC fact sheet can be downloaded at: http://www.cleancareseminars.com/carpet_cleaning_faq4.htm (IICRC, 2005)

28. Consider adopting the US EPA (2000) document, "Tools for Schools", as an instrument for maintaining a good indoor air quality environment in the building. This document is available at: http://www.epa.gov/iaq/schools/index.html.

29. Refer to resource manual and other related indoor air quality documents located on the MDPH's website for further building-wide evaluations and advice on maintaining public buildings. These documents are available at: http://mass.gov/dph/iaq.

The following **long-term** recommendations are made for consideration:

1. Consider replacing existing air handling system components with a new air handling system in order to provide mechanical fresh air supply as well as mechanical exhaust to all classrooms.

2. Consider eliminating carpeted surfaces from basement areas in the future. Prior to conducting any carpet removal, a determination must be made to ensure no deteriorated asbestos floor tiles are present. If present, remediate in accordance with all state and federal regulations.

References

ACGIH. 1989. Guidelines for the Assessment of Bioaerosols in the Indoor Environment. American Conference of Governmental Industrial Hygienists, Cincinnati, OH.

ASHRAE. 1989. Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigeration and Air Conditioning Engineers. ANSI/ASHRAE 62-1989.

ASHRAE. 1991. ASHRAE Applications Handbook, Chapter 33 "Owning and Operating Costs". American Society of Heating, Refrigeration and Air Conditioning Engineers, Atlanta, GA.

BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials and Code Administrators International, Inc., Country Club Hill, IL.

Burge, H.A. 1995. *Bioaerosols*. Lewis Publishing Company, Boca Raton, FL.

IICRC. 2002. Institute of Inspection, Cleaning and Restoration Certification. A Life-Cycle Cost Analysis For Floor Coverings in School Facilities.

IICRC. 2005. Carpet Cleaning FAQ 4 Institute of Inspection, Cleaning and Restoration Certification. Institute of Inspection Cleaning and Restoration, Vancouver, WA.

Lstiburek, J. & Brennan, T. 2001. Read This Before You Design, Build or Renovate. Building Science Corporation, Westford, MA. U.S. Department of Housing and Urban Development, Region I, Boston, MA.

Mass. Act. 2000. An Act Protecting Children and families from Harmful Pesticides. 2000 Mass Acts c. 85 sec. 6E.

MDFA. 1996. Integrated Pest Management Kit for Building Managers. Massachusetts Department of Food and Agriculture, Pesticide Bureau, Boston, MA.

MDPH. 1997. Requirements to Maintain Air Quality in Indoor Skating Rinks (State Sanitary Code, Chapter XI). 105 CMR 675.000. Massachusetts Department of Public Health, Boston, MA.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

Sanford. 1999. Material Safety Data Sheet (MSDS No: 198-17). Expo® Dry Erase Markers Bullet, Chisel, and Ultra Fine Tip. Sanford Corporation. Bellwood, IL.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

US EPA. 1992. Indoor Biological Pollutants. US Environmental Protection Agency, Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, research Triangle Park, NC. EPA 600/8-91/202 January 1992.

US EPA. 2000. Tools for Schools. Office of Air and Radiation, Office of Radiation and Indoor Air, Indoor Environments Division (6609J). EPA 402-K-95-001, Second Edition. http://www.epa.gov/iaq/schools/tools4s2.html.

US EPA. 2001. "Mold Remediation in Schools and Commercial Buildings". Office of Air and Radiation, Indoor Environments Division, Washington, DC. EPA 402-K-01-001. March 2001. Available at: http://www.epa.gov/iaq/molds/mold_remediation.html.

US EPA. 2006. National Ambient Air Quality Standards (NAAQS). US Environmental Protection Agency, Office of Air Quality Planning and Standards, Washington, DC. http://www.epa.gov/air/criteria.html.

Picture 1

Unit Ventilator (Univent)

Picture 2

Wall-Mounted Air Supply Vent from Old Gravity System

Picture 3

Passive Exhaust Vent

Picture 4

Blocked Exhaust Vent

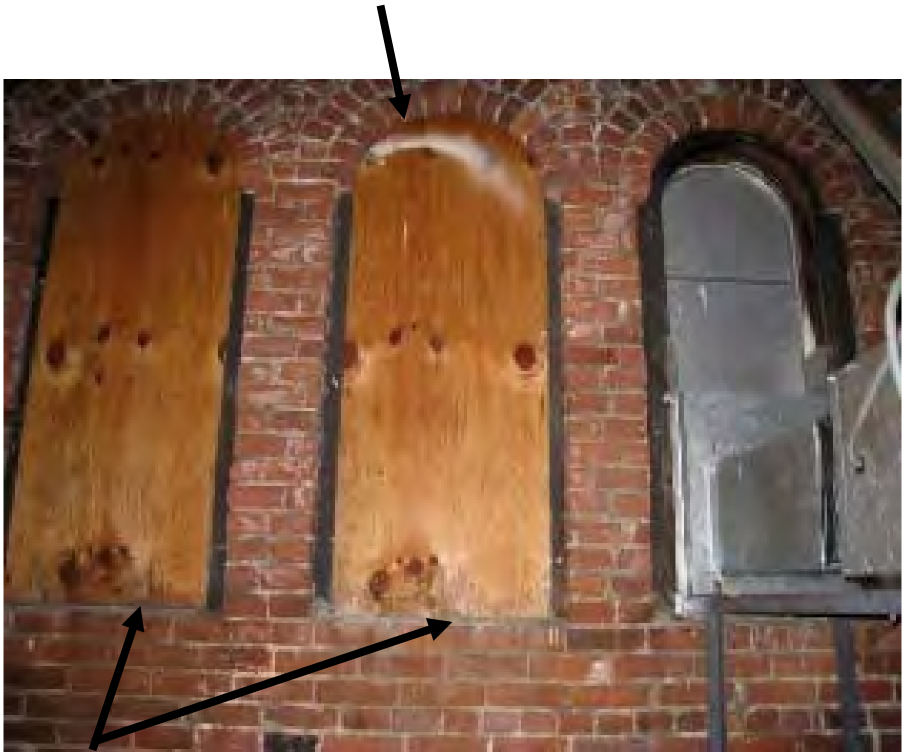
Picture 5

Water from Roof Leak Collected in Waste Receptacle

Picture 6

Hose Pumping Water from Attic out of Building

Picture 7



Windows Covered with Plywood are not Weathertight;
Note Light Visible at top of Window and Water Damage at Bottom of Plywood

Picture 8

Water-Damaged Ceiling and Wall

Picture 9

Porous Materials Stored in Attic

Picture 10

Standing Water in Boiler Room

Picture 11

Water Cooler Located over Carpeting

Picture 12

Loose, Broken and Missing Brick

Picture 13

Loose and Missing Mortar

Picture 14

Deteriorated Gutter (Arrow)

Picture 15

Open Downspout

Picture 16

Moss Growth on Masonry and Mortar

Picture 17

Moss Growth on Masonry Adjacent to Downspout

Picture 18

Window Casing is Buckled and Caulking is Deteriorated
Due to Loose and Missing Brick

Picture 19

Window in Disrepair

Picture 20

Deteriorated Window Caulking

Picture 21

Penetration in Masonry not Properly Sealed

Picture 22

Rodent Droppings in Attic

Picture 23

Shredded Material in Attic Indicative of Rodent Infestation

Picture 24

Penetration of Pipes through Gypsum Wallboard

Location: Alternative Education High School **Indoor Air Results**

Address: 111 Goodrich Street - Fitchburg **Date: 4/7/10**

Table 1

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 ($\mu g/m^3$)	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
background		85	27	466	ND	21				Sunny, warm, breezy, some clouds, wind speed 2 mph (west)
Basement										
Career Center Office	1	68	50	631	ND	15	Y	N	N	DO, carpet
Career Ctr. Alt Ed. Office	1	68	54	716	ND	16	Y	N	N	DO, carpet, UF
Career Center	2	68	52	641	ND	16	N	N	N	DO, carpet, dehumidifier, open utility holes in wall
Computer Room	0	70	50	666	ND	15	Y	N	N	DO, DEM, carpet, 17 comp., fan
Storage	0	68	50	544	ND	15	N	Y off	Y off	DO, carpet, open utility holes in wall, open pipe, dry drain in hallway sink
Boiler Room	0	65	60	501	ND	15	N	Y	N	Water on floor

ppm = parts per million
$\mu g/m^3$ = micrograms per cubic meter
ND = non detect
AD = air deodorizer
AP = air purifier
aqua. = aquarium
AT = ajar ceiling tile
BD = backdraft
CD = chalk dust
CP = ceiling plaster
CT = ceiling tile
DEM = dry erase materials
design = proximity to door
DO = door open
FC = food container
GW = gypsum wallboard
MT = missing ceiling tile
NC = non-carpeted
WP = wall plaster
PC = photocopier
PF = personal fan
plug-in = plug-in air freshener
PS = pencil shavings
sci. chem. = science chemicals
TB = tennis balls
terra. = terrarium
UF = upholstered furniture
VL = vent location
WD = water-damaged

Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Location: Alternative Education High School **Indoor Air Results**

Address: 111 Goodrich Street - Fitchburg **Date: 4/7/10**

Table 1 (continued)

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 ($\mu g/m^3$)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
Computer Room	12	66	60	781	ND	15	Y	N	N	DO, student bathrooms in hall exhibit WD CTs
First Floor										
Mrs. Smith (English)	14	68	51	662	ND	20	Y	Y	Y	Both supply and exhaust are blocked, carpet
Mrs. Porter	2	69	47	552	ND	17	Y	Y	Y	DEM, carpet
Mr. McNamara (History)	13	74	42	778	ND	18	Y	Y	Y	DEM, exhaust blocked
McComb	14	71	46	636	ND	18	Y	Y	Y	DEM, copiers, exhaust blocked
Second Floor										
Meeting Room	0	71	44	570	ND	17	Y	Y	Y	DO, carpet

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Table 1 (continued)

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McCormick	0	73	43	577	ND	15	Y	Y	Y	DO, DEM, dry drain, carpet, peeling paint
Middle School Room	(not available)									
Mr. Kahn	13	72	45	783	ND	16	Y	Y	Y	DO
Principal's Office (Mr. Pelland)	1	72	42	662	ND	20	N	N	N	DO, carpet
Front Lobby	3	77	39	518	ND	19	N	N	N	DO, carpet

ppm = parts per million
$\mu g/m^3$ = micrograms per cubic meter
ND = non detect
AD = air deodorizer
AP = air purifier
aqua. = aquarium
AT = ajar ceiling tile
BD = backdraft
CD = chalk dust
CP = ceiling plaster
CT = ceiling tile
DEM = dry erase materials
design = proximity to door
DO = door open
FC = food container
GW = gypsum wallboard
MT = missing ceiling tile
NC = non-carpeted
WP = wall plaster
PC = photocopier
PF = personal fan
plug-in = plug-in air freshener
PS = pencil shavings
sci. chem. = science chemicals
TB = tennis balls
terra. = terrarium
UF = upholstered furniture
VL = vent location
WD = water-damaged

Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Appendix B

An Information Booklet Addressing PCB-Containing Materials in the Indoor Environment of Schools and Other Public Buildings

Prepared by

Bureau of Environmental Health
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Appendix B

INTRODUCTION

The purpose of this information booklet is to provide assistance to school and public building officials and the general public in assessing potential health concerns associated with polychlorinated biphenyl (PCB) compounds in building materials used in Massachusetts and elsewhere. Recently, the U.S. Environmental Protection Agency (EPA) provided broad guidance relative to the presence of PCBs in building materials, notably PCBs in caulking materials. The most common building materials that may contain PCBs in facilities constructed or significantly renovated during the 1950s through the 1970s are fluorescent light ballasts, caulking, and mastic used in tile/carpet as well as other adhesives and paints.

This information booklet, developed by the Massachusetts Department of Public Health's Bureau of Environmental Health (MDPH/BEH), is designed to supplement guidance offered by EPA relative to potential health impacts and environmental testing. It also addresses managing building materials, such as light ballasts and caulking, containing PCBs that are likely to be present in many schools and public buildings across the Commonwealth. This is because the Northeastern part of the country, and notably Massachusetts, has a higher proportion of schools and public buildings built during the 1950s through 1970s than many other parts of the U.S. according to a 2002 U.S. General Accounting Office report. The Massachusetts School Building Authority noted in a 2006 report that 53 percent of over 1,800 Massachusetts school buildings surveyed were built during the 1950s through 1970s. This information booklet contains important questions and answers relative to PCBs in the indoor environment and is based on the available scientific literature and MDPH/BEH's experience evaluating the indoor environment of schools and public buildings for a range of variables, including for PCBs as well as environmental data reviewed from a variety of sources.

1. What are PCBs?

Polychlorinated biphenyl (PCB) compounds are stable organic chemicals used in products from the 1930s through the late 1970s. Their popularity and wide-spread use were related to several factors, including desirable features such as non-flammability and electrical insulating properties. Although the original use of PCBs was exclusive to closed system electrical applications for transformers and capacitors (e.g., fluorescent light ballasts), their use in other applications, such as using PCB oils to control road dust or caulking in buildings, began in the 1950s.

2. When were PCBs banned from production?

Pursuant to the Toxic Substance Control Act (TSCA) of 1976 (effective in 1979), manufacturing, processing, and distribution of PCBs was banned. While the ban prevented production of PCB-containing products, it did not prohibit the use of products already manufactured that contained PCBs, such as building materials or electrical transformers.

3. Are PCBs still found in building materials today?

Yes. Products made with PCBs prior to the ban may still be present today in older buildings. In buildings constructed during the 1950s through 1970s, PCBs may be present in caulking, floor mastic, and in fluorescent light ballasts. Available data reviewed by MDPH suggests that caulking manufactured in the 1950s through 1970s will likely contain some levels of PCBs. Without testing it is unclear whether caulking in a given building may exceed EPA's definition of PCB bulk product waste of 50 parts per million (ppm) or greater. If it does, removal and disposal of the caulk is required in accordance with EPA's TSCA regulations (40 CFR § 761).

4. Are health concerns associated with PCB exposure opportunities?

Although the epidemiological evidence is sometimes conflicting, most health agencies have concluded that PCBs may reasonably be anticipated to be a carcinogen, i.e., to cause cancer.

PCBs can have a number of non-cancer effects, including those on the immune, reproductive, neurological and endocrine systems. Exposure to high levels of PCB can have effects on the liver, which may result in damage to the liver. Acne and rashes are symptoms typical in those that are exposed to high PCB levels for a short period of time (e.g., in industry / occupational settings).

5. If PCBs are present in caulking material, does that mean exposure and health impacts are likely?

No. MDPH/BEH's review of available data suggests that if caulking is intact, no appreciable exposures to PCBs are likely and hence health effects would not be expected. MDPH has conducted indoor tests and reviewed available data generated through the efforts of many others in forming this opinion.

6. How can I tell if caulking or light ballasts in my building may contain PCBs?

If the building was built sometime during the 1950s through 1970s, then it is likely that the caulking in the building and/or light ballasts may contain some level of PCBs. Light ballasts manufactured after 1980 have the words "No PCBs" printed on them. If the light ballast does not have this wording or was manufactured before 1980, it should be assumed that it contains PCBs.

7. What are light ballasts?

A light ballast is a piece of equipment that controls the starting and operating voltages of fluorescent lights. A small capacitor within older ballasts contains about one ounce of PCB oil. If light bulbs are not changed soon after they go out, the ballast will continue to heat up and eventually result in the release of low levels of PCBs into the indoor air.

8. Does the presence of properly functioning fluorescent light ballasts in a building present an environmental exposure concern?

No appreciable exposure to PCBs is expected if fluorescent light ballasts that contain PCBs are intact and not leaking or damaged (i.e., no visible staining of the light lenses), and do not have burned-out bulbs in them.

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9. Should I be concerned about health effects associated with exposure to PCBs as a result of PCB-containing light ballasts?

While MDPH has found higher PCB levels in indoor air where light bulbs have burned-out, the levels are still relatively low and don't present imminent health threats. A risk assessment conducted recently at one school did not suggest unusual cancer risks when considering a worst case exposure period of 35 years for teachers in that school. Having said this, MDPH believes that facility operators and building occupants should take prompt action to replace bulbs and/or ballasts as indicated to reduce/eliminate any opportunities for exposure to PCBs associated with PCB-containing light ballasts.

10. When should PCB-containing light ballasts be replaced?

If ballasts appear to be in disrepair, they should be replaced immediately and disposed of in accordance with environmental regulatory guidelines and requirements. However, if light bulbs burn out, the best remedy is to change them as soon as possible. If light bulbs are not changed soon after they go out, the ballast will continue to heat up and eventually result in the release of low levels of PCBs into the indoor air. Thus, burned-out bulbs should be replaced promptly to reduce overheating and stress on the ballast. As mentioned, ballasts that are leaking or in any state of disrepair should be replaced as soon as possible.

It should be noted that although older light ballasts may still be in use today, the manufacturers' intended lifespan of these ballasts was 12 years. Thus, to the extent feasible or in connection with repair/renovation projects, the older light ballasts should be replaced consistent with the intended lifespan specified by the manufacturers.

11. Does MDPH recommend testing of caulking in buildings built during the 1950s - 1980?

Caulking that is intact should not be disturbed. If caulking is deteriorating or damaged, conducting air and surface wipe testing in close proximity to the deteriorating caulking will help to determine if indoor air levels of PCBs are a concern as well as determining the need for more aggressive cleaning. Results should be compared with similar testing done in an area without deteriorating caulking. In this way, a determination can be made regarding the relative contribution of caulking materials to PCBs in the general indoor environment.

12. What if we determine that caulking in our building is intact and not deteriorating?

Based on a review of available data collected by MDPH and others, the MDPH does not believe that intact caulking presents appreciable exposure opportunities and hence should not be disturbed for testing. As with any building, regular operations and maintenance should include a routine evaluation of the integrity of caulking material. If its condition deteriorates then the steps noted above should be followed. Consistent with EPA advice, if buildings may have materials that contain PCBs, facility operators should ensure thorough cleaning is routinely conducted.

13. Should building facilities managers include information about PCB-containing building materials in their Operations and Maintenance (O&M) plans?

Yes. All buildings should have an O&M plan that includes regular inspection and maintenance of PCB building materials, as well as thorough cleaning of surfaces not routinely used. Other measures to prevent potential exposure to PCBs include increasing ventilation, use of HEPA filter vacuums, and wet wiping. These O&M plans should be available to interested parties.

14. Are there other sources of PCBs in the environment?

Yes. The most common exposure source of PCBs is through consumption of foods, particularly contaminated fish. Because PCBs are persistent in the environment, most residents of the U.S. have some level of PCBs in their bodies.

15. Where can I obtain more information?

For guidance on replacing and disposing of PCB building materials, visit the US EPA website: http://www.epa.gov/pcbsincaulk/. For information on health concerns related to PCBs in building materials, please contact MDPH/BEH at 617-624-5757.